To Search or not to Search: Where is the Mobile Search Market Heading? Results from a Survey with Experts

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***Abstract*—Web search providers have a highly successful business model in place, which has rendered them amongst the most profitable companies on the internet. The mobile sector is expanding rapidly with the number of worldwide subscribers estimated to reach 5 billions by 2012 and with two-digit growth rates in the number of mobile internet connections. Consequently, many observers consider mobile search as the 'next big market'. However, there is little evidence so far to support such high expectations. In addition, we spot a general lack of studies based on large public data sets, which employ reproducible methods to forecast the evolution of trends in the sector. Surprisingly, whereas some market research reports dedicated solely to mobile search were published a few years ago, just when mobile search is moving to become a mainstream application, there appear to be no comprehensive recent studies about where the mobile search market is going.**

In this paper we report and analyse the collective opinions of a group of experts on the prospects of mobile search. The research we present is based on a two-round Delphi exercise. The first round of such exercise was conducted online in order to reach a wide community of experts and to cover a broad range of expertise. The second round was carried out face-to-face with a selection of respondents to discuss in depth the results of the online questionnaire. To get the prospective dimension into the Delphi discussion, we proposed seven distinct scenarios. This set a common ground for participants to engage into a forward-looking debate and to focus their attention onto prospective drivers and barriers rather than solely onto today's landscape.

Our Delphi study confirms the high expectations and bright future experts see for the mobile search market, but with noteworthy nuances. We found that the experts' optimism is rooted in the conviction that all critical technological components are already available and that only some system integration is missing. Our paper argues that there is no adequate market pull response to such technology push. Undeniably some (trial) applications are under way, but their business models are still insufficiently defined and companies are experimenting with different business ideas. Irrespectively of the business model, however, experts single out user-centric interfaces as the most critical element for increased mobile search take up. Today's interfaces and applications are not satisfactory in terms of users' needs and desires, which is delaying massive adoption. Another essential component for adoption is trust in the service provider. The liability and responsibility of the different players (telecom operators, search engine providers, device manufacturers, etc) needs to be scrutinized. Our study also presents the views of experts on how privacy and personal data usage are influencing the evolution of mobile search.

The paper concludes with some suggestions for fostering the evolution of the mobile search domain by increasing the interoperability of services, assuring the openness and mash-ups of content and services, developing personal identity data management systems to improve user acceptance and enhance trust and by supporting research, both on the technologies that are required to enable more advanced used of mobile search applications, and supporting living labs a experimental platform to test new application and innovative business models.

***Index Terms*— mobile, search, business models, expert opinion, policy options.**

I. Introduction

MOBILE search is a growing area, due to the increasing availability of content intended to satisfy the information needs of people on the move and increasing affordability of both mobile broadband connections and smart phones [1-2]. Mobile search can be defined as a mobile application "through which the user may submit a query (usually by entering a set of keywords) and get a list of results matching the search criteria" [3]. However, information retrieval on hand-held devices depends on the conditions in which search is performed, which are dynamic and likely to be influenced by the external context and the activity the user is carrying out. Contextual relevance is a distinctive aspect of mobile search but it also poses many challenges [4-5]. For such reason, mobile search is expected to overcome conventional web search, going beyond an adaptation of existing internet search solutions to the mobile interface [2, 6]. In addition, mobile devices are not only expected to become the primary connection tool to the Internet for most people in the world well before 2020 [7], but they are also seen as the

The manuscript was submitted on 15th February 2010. This work was supported in part by the European Commission's coordination action CHORUS+ (ICT-2009.1.5 Grant 249008).

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future bridge connecting the real and virtual worlds, e.g. as in mobile augmented reality and the internet of things. Mobile search is therefore likely to evolve so as to respond to information seeking patterns that demand a strong link between informational and physical worlds. In addition, it is considered to be a very promising area both in terms of empowerment of citizens and of new opportunities for mobile Internet service businesses, holding great promise for European competitiveness and growth [8-10].

Innovation is the key driver to fulfil these expectations and it depends, as in any other emergent domains, on a conjunction of technological, economic, social and regulatory factors. In the case of mobile search all of them are particularly relevant and encompass both hurdles and uncertainties. Firstly, technological innovation is spread over products and their components, services and their enablers, as well as covering infrastructure aspects. It comes along that the mobile search ecosystem stakeholders are diverse and heterogeneous, including device manufacturers, mobile network operators (MNO), infrastructure providers, mobile OS providers, web search players, and mobile-specific search players. The variety of players, technologies and approaches complicates interoperability and increases transaction costs. Secondly, it is not clear where economic value can be obtained from investment in the mobile search sector. Thirdly, it seems that mobile search is not yet being disruptively adopted by mobile users. Last, but not least, the sector is highly dependent on regulatory environment factors, ranging from international data roaming costs to spectrum allocation issues and privacy regulations.

Several market research reports dedicated solely to mobile search were published a few years ago – see for example [11-13]. Surprisingly, just when mobile search is moving to become a mainstream application, there appears to be no comprehensive recent studies about where the mobile search market is going. One reason for this may be the dynamics of this segment of the market with events happening so rapidly that it would be very hard to capture stable trends in the time span of a detailed study. This observation is supported by the fact that there are many web sites, blogs, forums, groups, etc where different information about major developments in the mobile search market is regularly published and discussed. Another reason is that there is a general lack of comprehensive publicly available data sets upon which verifiable predictions of the evolution trends in the sector could be made. These data may be available to the MNOs, device suppliers and some applications providers, but they typically do not disclose them.

The lack of quantifiable evidence makes it hard to understand where drivers and barriers lay and subsequently to identify and support positive transformations while avoiding undesirable development paths, e.g. a new kind of digital divide or abuses from significant market power. For such a reason, within the context of the Prospects of Mobile Search Project at IPTS it was decided to consult a group of mobile search experts and foster a debate with respect to the key dimensions of mobile search (technological evolution, emergence of innovative business models and user acceptance) so as to harness their opinion concerning the main issues that affect its future development. This paper presents the collective opinions of this group of experts, the way they see the future of mobile search, and what they think it can be done at policy level to pave the way for a desirable future for mobile search to come.

II. Methodology

The prospects of emerging technologies can be captured by foresight tools, such as Delphi, surveys and scenario building exercises [14-15]. Each such tool has advantages and disadvantages. Delphi techniques usually employ an iterative survey of expert opinions, normally aimed to facilitate the reach of some degree of consensus [16]. Scenario based evaluation on the other hand allows to elicit opinions based on specific contexts of use, accounting for user's motivations and activities and allowing for an exploration of the role technology, business models and user perceptions could play in that context [17].

To this regard, the aim of the activity was not to reach a consensus on alternative and mutually exclusive predictive views or policy options. Rather the objective was to foster a multi-stakeholder prospect of mobile search, pulling together different opinions to help build a shared understanding of the complex relations that are shaping the evolution of this area. Therefore, scenarios were used to facilitate understanding on the prospects of mobile search by providing a common ground for answering the questions and fostering a debate with academics and practitioners with different expertise. For this reason a final round of discussion of findings face to face was considered.

A. Delphi Method

The first round of the Delphi Exercise consisted in an online survey. In March 2009, we sent a questionnaire to 240 experts. 61 answers were collected, 27 from experts currently at industry and 34 from academia. The sample covered expertise in all necessary domains for the study. In particular, 41 respondents declared expertise in business/market development, 37 in user experience, 28 in technology, 12 in legal and 9 in regulatory issues.

The second round consisted in a face-to-face workshop, which took place in Seville (Spain) 14-15 April 2009. Nineteen (19) of the respondents of the first round survey were invited to take part, based on their field of expertise. The results of the survey (first round) were presented to the expert panel and ad-hoc responses to the presented results were recorded. Then a structured discussion was performed chaired by one the authors. Whenever necessary, supportive material was presented and critically analysed. Finally, both consensual results and diverging views were recorded.

The “conventional” Delphi method was complemented by a scenario building exercise. The authors provided the experts with seven distinct scenarios. The motivation was twofold:

first, to set a common ground for participants to engage into a forward-looking debate. Second, to poll experts' opinion on upcoming mobile search drivers and barriers with regard to technological, business and user acceptance issues. Experts were asked to elaborate on critical dimensions that are considered fundamental enablers of the wider deployment of mobile search, by having them exchange information, identify points of agreement, disagreement and uncertainty; create new shared understandings; and debate on the potential policy instruments to be applied.

The seven scenarios proposed to experts were built following a human-computer interaction approach [18-21], i.e. focusing on the description of concrete usage situations, where users interact with technology to achieve specific aims in a given context. The scenarios, which were not alternative one to the others, were developed so as to stage different:

- Levels of intensity of use of personal data
- Types of search paradigms ranging from “traditional” textual queries to “reality mining” where information is searched from physical objects.
- Contexts of use and activity types.
- Enabling technologies showing different levels of complexities of service provision.

Full details about the scenarios, and the related survey results are available in [22].

III. Analysis and results

The analysis of the answers collected through the online questionnaire and the following discussion during the face-to-face workshop, indicate a number of trends, which are discussed below.

A. Technology is not the problem…

Experts estimate that the technology required to make the envisioned services available on the market is either already there (e.g. broadband technologies, user friendly interfaces, mobile social computing, location based services) or will be available soon (e.g. Audiovisual Search, Wireless Sensor Networks as enabler for context-based services, 3D trackers). It is consensual amongst the experts who took part in our study that technology is expected to come ahead of the market, which can be clearly seen by comparing the time of arrival of technology developments and the applications that deploy them. A time lag is expected between the actual possibility of having a scenario enabled from a technological perspective and its reach to the mass market. This time lag seems to be bigger when scenarios envisage a complex infrastructure for service integration and imply some sort of partnership among different players.

A shorter time to market is more likely to occur in the take-up of conventional search adapted to the mobile environment in niche markets, followed by applications making a more intensive use of personal and social data to improve user experience in increasingly wider markets. Scenarios requiring more complex services will arrive last given the effort needed for the integration of technologies, the interoperability of content and applications, and advanced interconnected services.

Even though the Delphi exercise indicates that the critical factors for take-up of mobile search are economic rather than technological, the economic factors are difficult to assess due to unclear patterns. As a main finding the Delphi results suggest that users expect high-quality search services with an even better user experience than in PC-based ones, but without a dominant business model and showing that most of them are not willing to pay directly for such services. This fact supports the use of scenarios to complement the Delphi.

B. … but interfaces are critical

Looking at the role that technology is judged to play in the sector, experts were asked to choose the technological components that they evaluate as critical for deployment so that the different scenarios happen. Search technology does not constitute a bottleneck to the development of the area according to the experts. However, there are supportive technologies that would positively affect the take up of a number of services and applications (e.g. biosensors would allow the fruition of personalised services based on individual fitness features, while cognitive technologies could play an important role in the future of search depicted in the prospective scenarios, though they do not represent a bottleneck to the deployment of any of them). What emerges from the expert survey on scenarios is that mobile interfaces are expected to remain a critical issue for the full deployment of mobile search, due to the specificity of information search on the move.

C. Perceived usefulness is valuable, and disruptive applications are not yet there

The Delphi exercise included a question to collect expert opinion concerning what is the most important factor to enable a satisfactory user experience for each of the proposed scenarios. The overall opinion is that the challenge is to provide services whose usefulness to the end-user is clear and valuable.

Trust in the service provider has also been consensually identified as one of the most important factor for the adoption of advanced mobile search scenarios. Price is not a minor issue but again while it would be a barrier with respect to a leisure type of service, whereas it is not considered a barrier if the service is based on user-generated content.

According to experts the market is pulling towards personalised and context-aware applications and services, which could respond to users' needs on the move.

It is consensual that one of the main bottlenecks to the widespread deployment of mobile search is made up of the lack of a well-defined value proposition for mobile content fruition. Even though it is clear that the combination of context awareness with relevant, useful and interesting context-related information will make the difference in mobile search, disruptive applications proving this concept are missing.

Additionally ease-of-use and enhanced user-control are considered to contribute to the success of context-aware mobile search, together with social applications expected to evolve into fully-fledged “recommendation engines” that reap the benefits of personal networks and trusted relations.

Anticipatory applications, ranging from serendipity-based content discovery, to learning and entertainment, would be possible. Such applications would require a much higher level of user profiling and behavioural tracking than the level to which we are currently accustomed. This causes a dilemma. On the one hand, the lack of personalised data severely limits the usefulness of some applications. On the other hand, however, the fact that advanced personalised services require a lot of data about the user provokes privacy concerns.

D. Privacy: it is an opportunity rather than a constraint.

Privacy related issues make up a transversal matter affecting all scenarios where personal data are needed to provide a tailored service, however it privacy related issues are considered service dependent Looking at the comments experts made on the subject, there seem to be various opinions. There is a general consensus that privacy concerns grows as more and more data is becoming available to both the public administrations and private players. It is recognised that a privacy backlash could prejudice advanced mobile search. However, some experts think that privacy issues may be overrated in as far as search applications are concerned , if one considers that users already allow search engines and social media to know a lot of their personal details in order to be served better (customised search and geo-positioning). Others think that the boundaries of personal privacy will shift, that there is room for a market for privacy to emerge, but generally there is feeling that limits and measures have to be introduced to avoid undesired scenarios to be possible.

In relation to personal data protection, experts also pointed out that the mobile sector is characterised by a policy asymmetry between mobile carriers and application providers: whereas mobile network operators have to comply with obligations relating to data retention, application providers are not generally bound by such regulation.

E. Companies are still experimenting with business models

Experts have also been asked to associate a business model to each one of the proposed scenarios, in terms of likelihood for it to be the enabling one. Both the online survey and the workshop discussion indicate that a clear lack of strong business models. Experts' analysis is that enterprises are still in the phase of evaluating user responses to proposed services and still experimenting how exactly to monetise these services before embarking on large-scale deployment.

In response to the question about which is the most likely future business model for mobile search, the survey indicates that there is a slight preference for advertising based models, but no other business model can be clearly distinguished from the others as far as the survey scenarios are concerned. The experts remained unclear as to which of this model’s many variants will prevail. They also mentioned that the adaptation of advertising formats to the mobile environment is not a trivial issue.

This is not necessarily the case for all market actors. From experts discussions, it was acknowledged that the big providers of internet search (Google, Yahoo!, Bing, etc.) and social networks (Facebook, MySpace, Twitter, etc.) are interested in shaping mobile search as much as possible as an extension of their core activities and services and technological openness in this case may clash with business interests. Another relevant driver is the availability of context-based metadata-enabled content or, more generally, content enrichment. Ideally, such metadata would be automatically machine-generated. However, as long as semantics remain a challenge, meta-data will also rely upon users’ involvement. Mobile tagging is one example of content enrichment by the users.

Another potential business model would be to include mobile search technology as a function integrated within other products or services and to charge for the complete package. The services included would probably constitute a kind of add-on to traditional mobile communications services, or would be packaged with other product/services. In the case of the very personalised services making intensive user of sensitive personal data, experts would either see subscription as the most viable business model, or to have the mobile search application offered as a premium feature of either a the service provider.

Experts argued that if such services remain within the telecom operators’ domain (“walled garden” approach [23]), they will probably not lead to a sustainable model.

The proposed scenarios imply a much more open market where new players can deliver services that satisfy search needs in mobility, where cooperation amongst players is stronger than today's, and where the openness of the platforms players use and offer provides greater value to the user.

IV. DISCUSSION

The findings of our study highlight that search is considered a major business opportunity for growth in the mobile sector. Experts agree that there are no significant bottlenecks from a technological point of view. The basic technological components are either available on the market or soon will be. The massive adoption of mobile search, does not depend so much on technological components (although improved search algorithms or prospective cognitive technologies can enhance adoption), but rather on their integration into relevant interoperable services.

Mobile specific search goes far beyond web search adapted to mobile platforms and interfaces. Such a specificity can flourish in an environment were hardware becomes "senseware", where information coats objects and people, where social networks enhance the available information sorting it out on users' behalf, and where mobile devices becomes the entry point to a networked environment in which

"intelligence" is distributed across different elements.

At our workshop, experts discussed the main opportunities and challenges that are shaping the evolution of the mobile search sector in Europe, and will determine if a mobile specific search market will flourish in Europe. They acknowledge that, on the demand side, Europe enjoys a large base of early adopters of mobile search and a huge mass of mobile users with the economic strength to demand and pay for advanced mobile internet services that satisfy their expectations and requirements. On the supply side, Europe's industry is able to provide users with all the required technology. The industrial tissue is strong and readily available in all required sections of the mobile search ecosystem and particularly strong in some parts of it (telecommunications, handset producers and software and application providers). European companies have significant experience in past success stories (and failures) and, more importantly, they are increasingly pushed by the market, to simplify mobile tariffs and make services more affordable. Thus, a very positive conclusion is that Europe has both a strong supply and demand side in mobile search. Moreover, European industry is also actively involved in developing countries where mobile devices will become prime means to access the internet. This shared experience could become beneficial in both ways: spreading European innovations and learning from massive usage of mobile internet access.

Further Europe possesses a large collection of high quality information that may trigger advanced mobile search applications at the service of the citizens. Geo-data (e.g. cadastre), images and pictures (e.g. national libraries), or video (e.g. public broadcasters) are examples of data collections in the hands of public authorities, which have already been digitised to a very large extent, that could add significant value to mobile search services. Note that most of this content comes from public sources and/or its creation has been subsidised in the past by public institutions. It seems therefore that public administrations have not yet fully understood how they can exploit in the best possible way this value and how to get into various partnerships and collaborations to unlock its potential. The prospect of “liberation” of public data could also put governments into a favourable position to enforce an open and “loose interoperability” model to allow data portability across applications and players. Forthcoming disruptions in technology could help to deploy such models.

Finally, the many times used but also many times empty-of-practical application motto of “reaping the benefits of Europe’s cultural diversity” could become true in the mobile search domain. Some of the most promising applications of mobile search pivot around local information, local culture and specific languages, which is supposed to lead to the emergence of many niche markets and services. Civil society is increasingly aware of the need to establish digital identities, which in turn sets the conditions for a stable and firm framework to develop mobile (search) applications, both appealing to users and respectful with them and their preferences and motivations. Europe could be the first to put in place such a light-handed and user-empowered regime that could shift the interest of global innovators in mobile search.

Still there are many challenges and barriers to be overcome. The current mobile ecosystem is largely fragmented in terms of both techno-economic models and markets. On the techno-economic side, there are multiple layers (devices hardware and software, applications, networks, development platforms, content platforms, etc) composed of competing, closed and non-interoperable standards. On the market side, the European internal market is far from being established (think on roaming charges, for example) and recent practices (applications stores) keep the tradition of silo incompatible models. Mobile broadband connections are still expensive, particularly in many situations where mobile search would have an extreme value for users (such as finding places in foreign countries), high roaming charges dissuade users from even attempting to connect to the internet. Monetizing mobile search is also still a pending issue.

The potential delay in the adoption of appropriate regulation regimes (electronic communications, spectrum management, content, consumer protection, etc) will slow the adoption of mobile search. In this sense, a stable, clear and forward-looking framework is desirable which would address the new issues coming from advanced mobile applications.

Finally, there is a risk of a mobile digital divide. Next generation mobile infrastructures may not reach some geographical areas in the short to middle term and the prices both of devices and mobile connections are not affordable for many citizens.

In summary, according to experts, the future of mobile search will be influenced by the following factors:

- **Availability and affordability of mobile broadband** connections is the main enabler of mobile search. Europe has a good position in this emerging market and several key industry players are well prepared, but a number of issues remain to be solved to this regard: market fragmentation, roaming charges, mobile digital divide, interoperability and institutional and regulatory framework.
- **An open ecosystem for mobile search** is desirable for innovation to thrive. This openness refers to the adoption of open standards and to putting in place a “loose interoperability” concept similar to that of web 2.0 solutions.
- There is an ample **role for public action** in the mobile search domain. Potential actions refer to the “conventional” regulatory approach but also, and maybe more relevantly, to the use of the wealth of public data with potential high added value in various mobile search scenarios. The role of public administrations as deployers of applications could be the key, since they are the natural playfield for the convergence of the many stakeholders involved in mobile search applications.
- **Users have a definitive role to play** in the success of mobile search applications. They ought to contribute to innovations but they also need a granular and easy control of their mobile digital identities and personal data.

V. Potential Policy Implications

A number of possible policy options, previously identified by the research team, were submitted to expert during the workshop to harness their opinion on what policy actions would be more relevant and feasible to foster the mobile search market. The initial policy options were refined in the light of the trends, challenges and barriers discussed above, and the following list of possible policy recommendations, was then discussed to reach a consensus on a prioritisation exercise.

User-oriented policies aimed at the demand side of mobile search (policy options U):

- Enhance user-awareness of opportunities and risks (U.1)
- Create (policy-push) tools for user empowerment, i.e., for granular management of privacy or electronic identities (U.2)

Innovation-support policies (policy options S):

- Supporting innovators and entrepreneurs through an improvement of the institutional framework, i.e., access to venture capital, taxes, education, etc (S.1)
- Promoting living labs, in particular, for mobile applications and open access to them (S.2)
- Promoting research projects focused one missing technologies and enablers, i.e., FP-type (S.3)

Regulatory policies (policy options R):

- Reforming the mobile search regulatory framework, i.e., in electronic communications, e-commerce, privacy, consumer rights, etc (R.1)
- Promoting self regulation of the mobile search industry, i.e., codes of conduct (R.2)
- Harmonisation and enforcement of EU internal market (R.3)
- Mandate data portability suitable for mobile search applications (R.4)
- Creating and enforcing an independent agency, i.e., a watchdog for mobile data usage (R.5)

Industrial-type policies (policy options J):

- Promoting standards and interoperability (J.1)
- Promoting content production suitable for mobile search (J.2)
- Supporting a European champion in mobile search (J.3)
- Setting up a multi-stakeholder platform (J.4)
- Helping accelerate the deployment of 4G mobile broadband infrastructures (J.5)

Public involvement in the supply side of mobile search (policy options P):

- Development of mobile search public services, i.e., for cultural purposes in cities (P.1)
- Public procurement, i.e., public administration as buyers and users of mobile search applications (P.2)

No public involvement at all

Figure1 below shows the result of the discussion to prioritise potential policy intervention. Policy options are positioned with respect to their relative importance to the mobile search domain in Europe and the feasibility to put them into practice.

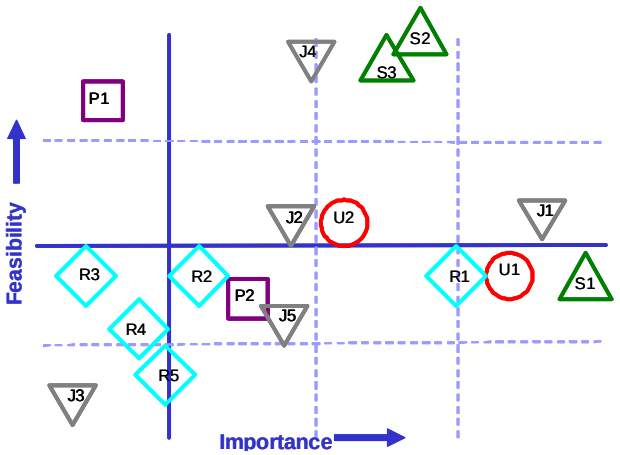

Figure 1.Positioning policy options for mobile search with respect to their relative importance to the domain and the feasibility to be put it into practice.

Policies in the upper-right quadrant are considered candidates to be implemented The overall vision on policy action is very balanced, showing that experts believe that the mobile search domain requires a combination of different types of policy actions to thrive and succeed, and that no single type of policy will suffice.

Looking in detail into each of the potential policy measures, in the first place, there is a need to push the demand side of mobile search, by raising the awareness of users and by empowering them with the tools to manage their data.

This should be complemented with reinforcing all polices aimed at innovation: from the support to innovators and entrepreneurs, to the use of living labs and the more traditional research programs.

On the regulation side, it is considered that the existing frameworks should be quickly reviewed and adapted to the new needs of advanced mobile applications. However, there is no much faith amongst experts in the self-regulation of the industry or in other actions beyond the regulatory framework like specific agencies or decisions.

From the industrial policy perspective, the idea of promoting the use and adoption of open standards and the achievement of a reasonable level of interoperability, including, if needed, a platform to gather all the stakeholders involved has considerable support by the experts. Helping to develop content for added value mobile search is also highly regarded. However, it is thought that neither supporting a European champion in the mobile search domain nor forcing a swifter deployment of 4G-type mobile communications infrastructures would be helpful.

Finally, experts suggest that for some niche mobile search applications public administrations can have a leading role, setting the conditions for their deployment or even becoming

their providers.

ACKNOWLEDGMENT

The authors would like to thank O. Westlund, S. Ramos, A. Jaokar, F. Álvarez, R. De Waele, G. Mateos-Barrado, and M. C. García-Jiménez, who contributed to the mobile search project.

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